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Self-Seal Adhesives

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95.1 Introduction

Cohesives, often referred to as "self-seal adhesives," are coatings which in a dry state exhibit the unique ability to selectively stick to themselves when brought together under pressure.

95.1.1 Adhesion and Cohesion

Natural rubber is the ingredient common to all self-seal adhesives. It is this raw material, generally utilized in the latex form, which confers or facilitates the ability to cohere.

Natural latex consists of long chain, high molecular weight molecules, the ends of which are thought to contain an extra double bond protected with a weak hydrogen-bonded protein molecule. It is believed that when such molecules are positioned in intimate contact and mechanical or thermal energy is introduced, the following reaction takes place. First, the weakly hydrogen-bonded protein molecule breaks from the long chain and second, stored elastic energy from within the molecule is released, causing molecular vibration. The subsequent entanglement of the chains and joining at the now-available bonding sites produces a molecular inseparable condition referred to as a cohesive seal (Figure 95.1, Figure 95.2, and Figure 95.3).

In application, the greater the number of bonding sites utilized to impart adhesion, the smaller the number remaining to facilitate subsequent adhesion.

Laboratory evaluation on the functionality of self-seal formulations confirms the significance of achieving an appropriate adhesive/cohesive balance relative to a specific substrate.

Through product selection or formula modification, it is possible to enhance or accentuate the adhesive or the cohesive properties, but not, however, without inversely diminishing the other set. A product exhibiting the appropriate adhesive/cohesive balance is chosen after considering the seal functionality requirements mandated by the application and other pertinent performance parameters. In addition, product selection can be made only after the influence of the specific substrate on the adhesive/cohesive balance has been acknowledged.

Coating weight also affects seal functionality. Approximately 3.5 g/m^2 is required to ensure proper film formation, generating optimum adhesive functionality; 5.0 g/m^2 is generally suggested as the coating weight offering the most reliable performance. Consequently, the adhesive/cohesive balance is typically evaluated at this coating weight, whereas 7.0 g/m^2 represents perhaps the highest commercially viable coating weight for one-pass applications that require enhancement of the cohesive functionality over that which is available through formulation.

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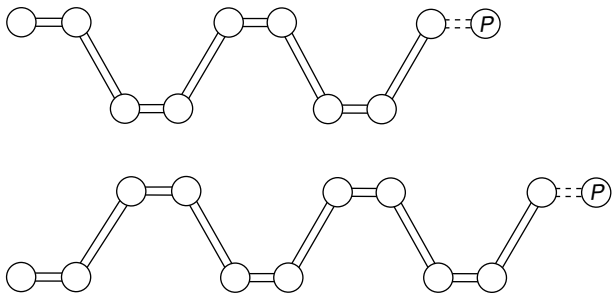

FIGURE 95.1 Long chain natural latex molecules.

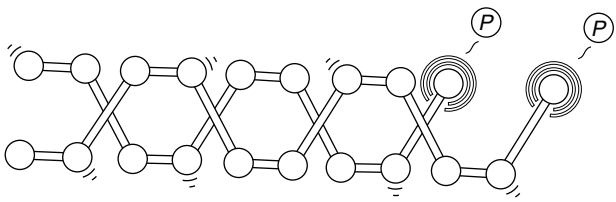

FIGURE 95.2 The effect of energy in seal formation: molecular excitation; severing of the "protein" molecule.

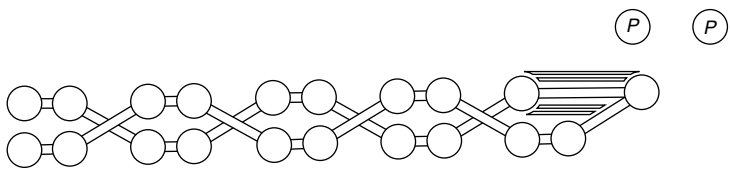

FIGURE 95.3 Cohesive seal consisting of both chemical bonds.

Drying or, more significantly, insufficient drying, can influence the performance of the product as well. Excessive retained moisture is the equivalent of a plasticizer addition, minimizing adhesion while accentuating cohesion. Additionally, retained moisture can create a roll blocking problem. Polyamide-based overprint lacquers typically employed for release can themselves become softened in the presence of excessive moisture.

Cohesives are dried at temperatures ranging from 50 to 90°C; however, drying is best accomplished at a web temperature of 60 to 70°C and through the use of a scrubbing zoned drying, or otherwise minimizing the amount of moisture-laden recirculated air.

95.1.2 Seal Performance

Eminently important in evaluating, testing, and anticipating seal performance is an understanding of the significance of the mode of failure. Simply stated, observe and record whether the seal strength obtained represents an adhesive, cohesive, or substrate failure. In these respective cases, the self-seal is not adhering to the substrate, the self-seal is not adequately sticking to itself, or delamination or fiber tear/film destruct, is occurring.

Some further descriptive commentary on the mode of failure is appropriate:

- *Webby:* adhesive failure (en masse release from one or the other side)
- *Leggy:* adhesive failure (tenacious, elongating, rubber-like bands)
- *Stringy:* cohesive failure (short or fine elastic strands, splitting seal)
- *100% cohesive failure* (visually appears undisturbed, as before sealing)

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Thus, significant in evaluating seal performance is the recording of the procedures utilized in testing. Test methods used should relate as closely as possible to the actual conditions employed in commercial seal formation.

Self-seals are pressure respondent. The greater the pressure, the more immediate the cohesion response. However, the introduction of mechanical energy can help to form a bond and generate a suitable response in a mature seal. A seal is considered to be mature after 1 h, but some minimal increase in strength may continue to develop for up to 24 h before a fully stabilized condition is achieved. Typically associated with an increase in seal strength is a change in the mode of failure. For instance, a 100% cohesive failure at 300 g/25 mm could yield a substrate destruct seal at 800 g/25 mm with increased pressure or aging. No such similar change or improvement would be realized from a seal exhibiting an adhesive failure. It is only the developing cohesive response that is subject to this improvement.

As already mentioned, it is an accepted practice to utilize polyamide-based overprint lacquers to inhibit roll blocking. Careful consideration must, in fact, be given to selecting an ink-overprint system that is specific to the substrate and suitable for use in conjunction with self-seals. This not only assures proper release and eliminates ink pick, but also minimizes the potential for offset contamination. Offset contamination is represented by an accumulation of migrating slip or release modifiers from the printed surface to the surface of the self-seal, diminishing or inhibiting the subsequent cohesive response.

95.2 Application Techniques

In relaying techniques and procedures developed to facilitate cohesive applications via gravure, it is appropriate to define some of the inherent product limitations and physical characteristics that affect their use.

95.2.1 Handling

Cohesives are perishable. They have a suggested shelf life, and proper rotation of inventory is required.

Cohesives must be protected from freezing; ideally they are stored at 10 to 30°C in tightly closed containers.

Although as a general rule cohesives are not subject to settling, they do, in fact, stratify, as a result of their low viscosity and variable specific gravity, and must therefore be well stirred before use.

Cohesives are susceptible to contamination. Transfer of material should be made only to clean, water-rinsed containers.

Particulate matter and/or solvents, including alcohol, will reduce mechanical stability, and cohesive formulations should not be adulterated. Any such modifications can interfere with product performance.

It is advisable to discard used cohesive rather than returning it to a storage container; this eliminates the possibility of cross-contaminating fresh material.

Cleanup is best accomplished with cool water. Ammoniated water or alkali detergent may also be used. Completely dried material may be stripped or peeled from equipment. The use of solvent is not recommended.

Cohesives are preserved with ammonia, which is highly corrosive to copper and/or copper alloys. Additionally, the incorporation of copper ions into a cohesive will cause accelerated degradation. Therefore, any such contact must be avoided.

As copper is typically employed as the base for gravure cylinders, it is imperative that a hard, impervious chrome plating be utilized over 100% of the cylinder. Sometimes a nickel flash is employed immediately under the chrome for added protection.

Cohesives stabilized for machinability may be shear sensitive, and excessive shear must be avoided.

Cohesives should not be pumped by means of gear pumps routinely used for inks. A diaphragm pump can be utilized. However, a systaltic pump employing alkali-resistant flexible tubing is preferred.

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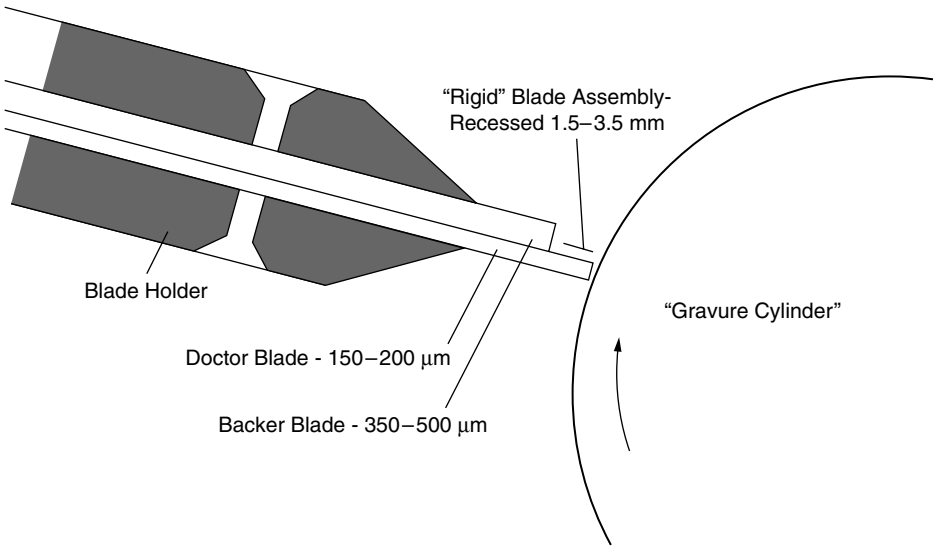

FIGURE 95.4 Schematic of a rigid blade assembly.

95.2.2 Procedures

Experience has shown that shear generated by blade doctoring can be minimized through maintaining as steep an angle as possible (i.e., 90° tangent to the cylinder). It is suggested that a well-dressed, rigid blade assembly be utilized; typically blue steel 150 to 200 μm doctor, 350 to 500 μm backer, recessed 1.5 to 3.5 mm (Figure 95.4).

To further reduce shear generated at the doctor blade in pattern applications, scavenger bars on overall etching of cylinder ends should be considered. Oscillating the blade through the widest parameters and at its fastest speed will also aid in the elimination of particles formed in the land areas. Also suggested is the under cutting of the impression roll to eliminate inadvertent backside coating, should shear-generated particles cause the ends of the blade to lift (Figure 95.5, Figure 95.6).

Ammonia, used as a volatile preservative, functions as the secondary stabilizer as well. During intermittent or low usage runs, aeration may cause a reduction in the ammonia level sufficient to create machining difficulties. In such situations, nondetergent 26° Be (29.4%) ammonium hydroxide should be added to a pH of 9.5 to 10.5.

Cohesives are quick drying, facilitating their utilization on high speed converting equipment. However, unlike solvent-borne inks, once dry they will not redisperse in themselves. Therefore, to minimize drying

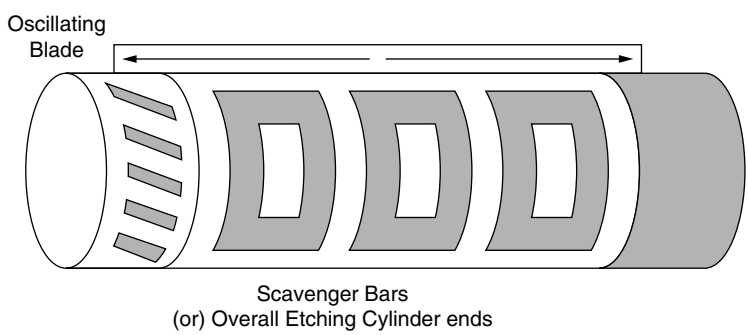

FIGURE 95.5 Schematic of a gravure cylinder with scavenger bars, 100% etching of a cylinder end, and oscillating doctor blade.

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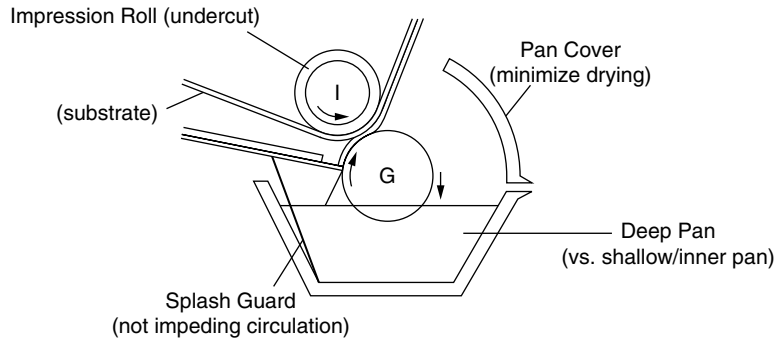

FIGURE 95.6 Schematic of a gravure station.

in the application station, it is suggested that all other "make-ready" be accomplished before cohesive is added to the pan. Once added, the gravure cylinder must be kept rotating, ideally flooding the cylinder when not actually coating. Before it is dropped or reseated, the blade should be wiped with a rag moistened with water, remove any dried material or other contaminants.

The pan ideally should be deep, thereby increasing volume, and covered if possible, with the flow not restricted by inappropriate positioning of the splash guard.

Additionally, thought should be given to minimizing hot drafts from the driers onto the application station.

Rewind tension should be carefully controlled to avoid blocking from too tight a roll. Cohesives exhibit antitelescoping frictions, and low rewind tensions are indeed functional in this respect. Cohesive-coated wrap typically produces noise through the rewind and slitting operations because of the inherent tendency to cling.

Converted rolls should be cradled or stored on end, rather than on their sides. This is to reduce intermittent blocking, which could be caused by the weight of the roll.

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